MONTHLY NOTICES

OF THE

ROYAL ASTRONOMICAL SOCIETY.

VOL. XLVII. JANUARY 14, 1887. No. 3

J. W. L. GLAISHER, M.A., F.R.S., President, in the Chair.

Rev. W. Birks, Wanstead Villa, Villiers Road, Southsea;
Captain Thomas Exham, Officers' Club, Canute Road, Southampton;
Shelley Fisher, The Priory, Larkhall Rise, S.W.;
Cuthbert Hutchinson, Rock Lodge, Roker, Sunderland;
William Edward Jackson, Constantinople;
Captain Thomas Mackenzie, Royal Mail s.s. "Moselle," Southampton;
Horace Pearce, F.G.S., F.L.S., The Limes, Stourbridge; and
James Cruikshank Roger, The Grange, Walthamstow, Essex;

were balloted for and duly elected Fellows of the Society.

Observations of the Moon made at the Radcliffe Observatory, Oxford, during the year 1886, *and a Comparison of the Results with the Tabular Places from Hansen's Lunar Tables.* By E. J. Stone, M.A., F.R.S.

The present Paper contains the Right Ascensions and North Polar Distances of the Moon as deduced from the observations made at the Radcliffe Observatory during the year 1886. These results are here compared with those deduced from Hansen's Lunar Tables on two suppositions:—

(1) That the mean times, found in the usual way from the sidereal times at mean noon given in the *Nautical Almanac*, were *not* changed in 1864.

(2) That the mean times *were* changed in 1864, in accordance with the views which I have explained in Papers already communicated to the Society.

For facilities for an accurate comparison between Hansen's Lunar Tables and Observations we are again indebted to the places published in the *Connaissance des Temps.*

TABLE I.

Radcliffe Observations of the Moon, 1886.

Correction to be subtracted from M.T. for change of Sidereal Time at Mean Noon since 1864.	Day, 1886.	Observer.	Observed R.A.	Seconds of Hansen's R.A.	Hansen *minus* Observed. **Uncorrected** for Error in Time.	Correction due to Error in Time.	Hansen *minus* Observed. **Corrected** for Error in Time.	Observed N.P.D.	Seconds of Hansen's N.P.D.	Hansen *minus* Observed. **Uncorrected** for Error in Time.	Correction due to Error in Time.	Hansen *minus* Observed. **Corrected** for Error in Time.
s			h m s	s	s	s	s	° ′ ″	″	″	″	″
32·77	Jan. 13	R.	1 42 43·61	44·22	+0·61	−1·13	−0·52	82 47 36·54	32·87	−3·67	+5·14	+1·47
32·77	14	W.	2 35 15·17	15·81	+0·64	−1·19	−0·55	79 3 23·17	19·32	−3·85	+4·68	+0·83
32·77	15	R.	3 31 3·83	4·33	+0·50	−1·26	−0·76	75 47 4·11	1·00	−3·11	+3·88	+0·77
32·79	18	R.	6 39 11·33	12·04	+0·71	−1·45	−0·74	71 37 18·45	16·69	−1·76	−0·72	−2·48
32·79	19	R.	7 45 39·16	40·07	+0·91	−1·45	−0·54	72 52 52·47	54·03	+1·56	−2·58	−1·02
32·88	Feb. 11	W.	3 9 2·33	3·00	+0·67	−1·20	−0·53	77 9 16·05	13·89	−2·16	+4·13	+1·97
32·93	23	F.B.	15 6 15·95	17·27	+1·32	−1·19	+0·13	102 39 10·57	14·24	+3·67	−4·16	−0·49
32·94	25	R.	16 53 13·22	14·48	+1·26	−1·17	+0·09	107 14 32·31	35·33	+3·02	−1·88	+1·14
33·01	Mar. 15	R.	7 46 9·80	10·38	+0·58	−1·38	−0·80	72 57 59·61	60·41	+0·80	−2·40	−1·60
33·01	16	W.	8 48 35·22	36·12	+0·90	−1·37	−0·47	75 22 44·65	48·38	+3·73	−3·94	−0·21
33·02	17	F.B.	9 50 14·33	15·17	+0·84	−1·35	−0·51	78 51 16·77	20·33	+3·56	−5·19	−1·63
33·03	19	R.	11 49 33·45	34·28	+0·83	−1·29	−0·46	87 49 5·18	10·27	+5·09	−6·36	−1·27
33·04	23	F.B.	15 35 35·70	37·02	+1·32	−1·22	+0·10	104 15 27·99	31·44	+3·45	−3·70	−0·25
33·13	April 15	W.	11 22 57·39	58·28	+0·89	−1·27	−0·38	85 36 32·83	36·33	+3·50	−6·16	−2·66
33·25	May 14	R.	12 54 6·09	6·87	+0·78	−1·22	−0·44	93 3 34·16	38·72	+4·56	−6·09	−1·53
33·25	15	F.B.	13 48 56·08	57·18	+1·10	−1·22	−0·12	97 27 30·09	34·93	+4·84	−5·63	−0·79

Day, 1886.	Observer.	Observed R.A.	Seconds of Hansen's R.A.	Hansen *minus* Observed. **Uncorrected** for Error in Time.	Correction due to Error in Time.	Hansen *minus* Observed. **Corrected** for Error in Time.	Observed N.P.D.	Seconds of Hansen's N.P.D.	Hansen *minus* Observed. **Uncorrected** for Error in Time.	Correction due to Error in Time.	Hansen *minus* Observed. **Corrected** for Error in Time.	Correction to be subtracted from M.T. for change of Sidereal Time at Mean Noon since 1864.
		h m s	s	s	s	s	° ′ ″	″	″	″	″	s
May 18	W.	16 35 18·29	19·69	+1·40	−1·24	+0·16	106 57 21·00	22·57	+1·57	−2·50	−0·93	33·27
June 15	W.	17 9 4·71	5·92	+1·21	−1·23	−0·02	107 56 14·29	15·38	+1·09	−1·76	−0·67	33·38
July 12	R.	16 50 56·44	57·47	+1·03	−1·22	−0·19	107 21 30·94	32·87	+1·93	−2·23	−0·30	33·49
14	F.B.	18 39 6·98	8·08	+1·10	−1·21	−0·11	108 44 24·93	24·34	−0·59	+0·37	−0·22	33·49
15	F.B.	19 32 7·40	8·67	+1·27	−1·18	+0·09	108 0 28·00	25·90	−2·10	+1·59	−0·51	33·50
17	F.B.	21 13 58·17	59·61	+1·44	−1·12	+0·32	104 4 48·16	44·41	−3·75	+3·59	−0·16	33·51
20	R.	23 36 50·09	51·18	+1·09	−1·05	+0·04	94 0 33·29	30·72	−2·57	+5·22	+2·65	33·52
Aug. 11	W.	19 15 5·48	6·67	+1·19	−1·18	+0·01	108 17 33·79	33·65	−0·14	+1·17	+1·03	33·61
13	W.	20 57 25·08	26·20	+1·12	−1·13	−0·01	104 56 8·29	5·53	−2·76	+3·28	+0·52	33·61
20	F.B.	2 31 43·95	44·95	+1·00	−1·14	−0·14	79 58 35·59	32·29	−3·30	+4·77	+1·47	33·64
Sept. 7	R.	18 58 9·93	10·94	+1·01	−1·20	−0·19	108 29 50·55	51·73	+1·18	+0·78	+1·96	33·71
10	W.	21 30 32·34	33·45	+1·11	−1·11	0·00	103 9 24·48	22·32	−2·16	+3·85	+1·69	33·73
11	R.	22 18 45·79	46·63	+0·84	−1·08	−0·24	100 4 15·68	10·81	−4·87	+4·54	−0·33	33·73
13	W.	23 52 55·22	56·56	+1·34	−1·06	+0·28	92 44 27·02	23·58	−3·44	+5·33	+1·89	33·74
15	W.	1 27 17·77	18·92	+1·15	−1·09	+0·06	84 50 46·47	42·60	−3·87	+5·30	+1·43	33·75
16	R.	2 15 59·36	60·41	+1·05	−1·12	−0·07	81 4 44·89	41·81	−3·08	+4·94	+1·86	33·75
17	W.	3 6 27·27	28·49	+1·22	−1·17	+0·05	77 39 46·36	43·98	−2·38	+4·33	+1·95	33·75
Oct. 4	R.	18 38 41·48	42·59	+1·11	−1·23	−0·12	108 44 13·39	14·35	+0·96	+0·33	+1·29	33·82
8	R.	22 2 9·21	10·29	+1·08	−1·09	−0·01	101 15 23·86	20·40	−3·46	+4·35	+0·89	33·84

Correction to be subtracted from M.T. for change of Sidereal Time at Mean Noon since 1864.	Day, 1886.	Observer.	Observed R.A.	Seconds of Hansen's R.A.	Hansen *minus* Observed. **Uncorrected** for Error in Time.	Correction due to Error in Time.	Hansen *minus* Observed. **Corrected** for Error in Time.	Observed N.P.D.	Seconds of Hansen's N.P.D.	Hansen *minus* Observed. **Uncorrected** for Error in Time.	Correction due to Error in Time.	Hansen *minus* Observed. **Corrected** for Error in Time.
s			h m s	s	s	s	s	° ′ ″	″	″	″	″
33·85	Oct. 11	R.	0 23 41·56	42·43	+0·87	−1·08	−0·21	90 8 28·22	23·68	−4·54	+5·50	+0·96
33·86	13	F.B.	1 59 56·03	57·30	+1·27	−1·13	+0·14	82 12 44·46	40·54	−3·92	+5·19	+1·27
33·93	Nov. 1	R.	19 10 4·62	5·88	+1·26	−1·24	+0·02	108 38 45·57	44·85	−0·72	+1·08	+0·36
33·94	2	W.	20 3 20·88	21·97	+1·09	−1·19	−0·10	107 24 16·13	11·35	−4·78	+2·29	−2·49
33·95	5	R.	22 31 49·12	50·18	+1·06	−1·09	−0·03	99 22 22·56	18·54	−4·02	+4·77	+0·75
33·96	8	R.	0 52 52·63	53·57	+0·94	−1·09	−0·15	87 44 23·14	18·64	−4·50	+5·59	+1·09
33·97	9	W.	1 41 13·85	14·95	+1·10	−1·12	−0·02	83 42 20·76	18·06	−2·70	+5·44	+2·74
34·05	Dec. 1	F.B.	21 23 49·37	50·65	+1·28	−1·14	+0·14	104 5 47·60	45·37	−2·23	+3·85	+1·62
34·06	2	R.	22 12 36·64	37·72	+1·08	−1·10	−0·02	101 1 34·56	30·42	−4·14	+4·57	+0·43
34·06	3	W.	22 59 57·40	58·49	+1·09	−1·07	+0·02	97 30 33·12	30·25	−2·87	+5·09	+2·22
34·07	4	F.B.	23 46 32·35	33·37	+1·02	−1·07	−0·05	93 40 47·51	44·27	−3·24	+5·44	+2·20
34·08	7	W.	2 9 26·08	27·02	+0·94	−1·15	−0·21	81 38 4·42	0·67	−3·75	+5·31	+1·56
34·09	9	W.	3 54 44·79	45·70	+0·91	−1·27	−0·36	74 48 9·89	6·06	−3·83	+3·86	+0·03
34·09	10	R.	4 51 47·64	48·67	+1·03	−1·33	−0·30	72 24 47·87	45·61	−2·26	+2·64	+0·38
	Mean of Errors without regard to sign ...			...	...	s 1·032	s 0·225	... ...	...	″ 2·960	...	″ 1·224
	Mean Errors for Year		...	...	...	...+1·032	...	−0·158	... ...	...	...	...

Observers: W., Mr. W. Wickham; R., Mr. W. H. Robinson; F.B., Mr. F. A. Bellamy.

TABLE II.

Radcliffe Observations of the Moon, 1886.

Errors of the Moon's Tabular Place in Longitude and Ecliptic Polar Distance, "Uncorrected" and "Corrected" for the change in Mean Time introduced in 1864.

Day.		Errors of Longitude (Hansen *minus* Observed.)		Errors of E.N.P.D. (Hansen *minus* Observed.)	
		Uncorrected.	**Corrected.**	**Uncorrected.**	**Corrected.**
1886.					
Jan.	13	+ 9″80	− 7″76	−0″16	−1″41
	14	+10·18	− 7·97	−0·73	−1·73
	15	+ 7·83	−10·95	−1·28	−1·90
	18	+ 9·99	−10·71	−2·46	−1·74
	19	+13·16	− 7·82	−0·79	+0·37
Feb.	11	+10·05	− 8·02	+0·57	−0·20
	23	+19·66	+ 1·70	−1·79	−0·99
	25	+18·32	+ 1·41	+0·96	+0·99
March	15	+ 8·35	−11·61	−0·69	+0·47
	16	+13·62	− 6·65	+0·10	+1·62
	17	+12·86	− 7·63	−0·80	+0·99
	19	+13·44	− 6·83	−0·29	+1·58
	23	+19·53	+ 1·36	−1·15	−0·58
April	15	+13·61	− 6·27	−2·00	−0·21
May	14	+12·56	− 6·68	−0·32	+1·14
	15	+17·05	− 1·95	−1·30	−0·10
	18	+20·18	+ 2·15	−1·33	−1·25
June	15	+17·36	− 0·34	−0·41	−0·64
July	12	+14·92	− 2·75	+0·16	+0·03
	14	+15·67	− 1·55	+0·49	−0·33
	15	+18·26	+ 1·35	+0·74	−0·30
	17	+21·14	+ 4·50	+2·68	+1·24
	20	+16·00	− 0·50	+4·11	+2·67
Aug.	11	+16·87	+ 0·01	+2·07	+1·04
	13	+16·36	− 0·28	+1·89	+0·46
	20	+15·12	− 2·44	+1·52	+0·74
Sept.		+14·22	− 2·89	+2·62	+1·68
	10	+16·08	− 0·53	+3·08	+1·60
	11	+13·34	− 3·19	−0·09	−1·58

Day.		Errors of Longitude (Hansen *minus* Observed.)		Errors of E.N.P.D. (Hansen *minus* Observed)	
		Uncorrected.	Corrected.	Uncorrected	Corrected.
1886.		"	"	"	"
Sept.	13	+19·80	+ 3·10	+4·85	+3·40
	15	+17·44	+ 0·30	+2·77	+1·66
	16	+15·75	− 1·60	+2·24	+1·41
	17	+17·90	+ 0·17	+2·63	+2·08
Oct.	4	+15·73	− 1·79	+2·00	+1·17
	8	+16·09	− 0·45	+2·25	+0·78
	11	+13·82	− 3·28	+0·99	−0·36
	13	+19·12	+ 1·51	+2·84	+1·91
Nov.	1	+17·93	+ 0·24	+1·43	+0·39
	2	+16·27	− 0·89	−1·48	−2·73
	5	+16·06	− 0·69	+2·06	+0·53
	8	+14·77	− 2·50	+1·32	+0·13
	9	+16·31	− 1·27	+3·38	+2·45
Dec.	1	+18·40	+ 1·44	+3·64	+2·17
	2	+16·34	− 0·43	+1·78	+0·30
	3	+16·08	− 0·58	+3·60	+2·16
	4	+15·31	− 1·56	+3·10	+1·72
	7	+14·44	− 3·47	+1·17	+0·42
	9	+13·71	− 5·11	−1·01	−1·05
	10	+14·96	− 4·32	−0·53	−0·12
Mean of Errors, without regard to sign	...	**15″·342**	**3″·316**	**1″·666**	**1″·153**
Mean Errors for Year		**+15″·342**	**−2″·531**	...	...

TABLE III.

Mean Excess over Observation of the "Moon's Tabular Place in Longitude," for the Years 1847 *to* 1886, *as computed from Hansen's Tables.*

"Uncorrected" and "Corrected" on and after 1864 *for the change in Mean Tabular Time introduced in the year* 1884.

Year.	Errors of Longitude (Hansen *minus* Observed.)		Year.	Errors of Longitude. (Hansen *minus* Observed.)	
	Uncorrected.	Corrected.		Uncorrected.	Corrected.
	"	"		"	"
1847	+1·07	+1·07	1852	− 0·92	−0·92
1848	+0·20	+0·20	1853	− 1·63	−1·63
1849	−0·47	−0·47	1854	− 1·68	−1·68
1850	−0·28	−0·28	1855	− 0·87	−0·87
1851	−1·29	−1·29	1856	− 0·96	−0·96

Year.	Errors of Longitude (Hansen *minus* Observed.) Uncorrected.	Corrected.	Year.	Errors of Longitude (Hansen *minus* Observed.) Uncorrected.	Corrected.
1857	−1″·86	−1″·86	1872	+7″·31	+0″·10
1858	−1·98	−1·98	1873	+8·24	+0·20
1859	−1·80	−1·80	1874	+9·29	+0·56
1860	−2·90	−2·90	1875	+9·87	+0·36
1861	−2·19	−2·19	1876	+9·80	−0·51
1862	−2·83	−2·83	1877	+9·23	−1·90
1863	−1·61	−1·61	1878	+8·22	−3·60
1864	+0·12	−0·81	1879*	+9·63	−3·12
1865	+1·27	−0·22	1880	+10·89	−2·77
1866	+2·14	−0·22	1881	+10·51	−4·06
1867	+3·48	+0·36	1882†	+12·68	−2·51
1868	+4·12	+0·28	1883	+14·71	−1·50
1869	+4·28	−0·35	1884	+14·65	−1·91
1870	+4·83	−0·66	1885	+15·14	−1·87
1871	+6·96	+0·44	1886‡	+15·34	−2·53

Radcliffe Observatory, Oxford:
1887, *January* 4.

Mean Right Ascensions of Polaris, Cephei 51 (*Hev.*), *δ Ursæ Minoris, and λ Ursæ Minoris for the year* 1887, *from the Radcliffe Observations of the years* 1880 *to* 1886. By E. J. Stone, M.A., F.R.S.

From the year 1880 to the year 1886 the azimuth errors of the Transit Circle at the Radcliffe Observatory have been based on the *Nautical Almanac* places of the stars *Polaris*, *Cephei* 51 (*Hev.*), *δ Ursæ Minoris*, *λ Ursæ Minoris*, after the application of corrections kindly furnished by the Astronomer Royal from year to year. The azimuth errors thus found agree well *inter se*, except those found from *Polaris* and *Polaris* S. P., which differ more than is desirable from each other and from the results found from observations of the other three stars. It has, therefore, been thought necessary to collect the results. It will be seen that the Right Ascensions of the Radcliffe Observations agree remarkably closely with the corrected *Nautical Almanac* places given by the Astronomer Royal for the three stars, *Cephei* 51, *δ Ursæ Min.*, and *λ Ursæ Min.*, but that the resulting Right Ascensions of *Polaris* agree much more closely with the tabular Right Ascensions of the *Berliner Jahrbuch*.

* All to 1879, Greenwich Observations.
† 1880 to 1882, Mean of Greenwich and Radcliffe.
‡ 1883 and since, Radcliffe only.

The resulting Right Ascensions for 1887 will be employed in the reductions of the Radcliffe Observations during the year 1887.

Annual Results reduced to 1887.

Year.	Mean R.A. from Radcliffe Observations reduced to 1887.	Number of Observations.	Adopted Proper Motion.
	Polaris.		
	h m s		s
1880	1 17 20·84	15	+0·1179
1881	21·55	24	
1882	21·75	67	
1883	21·18	62	
1884	21·92	52	
1885	21·68	83	
1886	21·72	49	
	Cephei 51 (*Hev.*).		
1880	6 47 16·38	9	−0·0385
1881	16·42	31	
1882	16·39	24	
1883	16·56	27	
1884	16·44	37	
1885	16·43	21	
1886	16·75	21	
	δ *Ursæ Minoris.*		
1880	18 8 46·18	5	+0·0285
1881	45·66	25	
1882	45·71	21	
1883	45·75	20	
1884	46·01	30	
1885	45·93	17	
1886	45·97	28	
	λ *Ursæ Minoris.*		
1880	19 36 53·24	3	−0·0500
1881	47·31	26	
1882	47·50	25	
1883	48·38	19	
1884	47·68	21	
1885	47·35	11	
1886	48·53	4	

Comparison of Mean Results with Tabular Right Ascensions.

Name of Star.	Mean of R.A. from Radcliffe Observations reduced to 1887.	Tabular R.A. from the *Nautical Almanac* for 1887.	Tabular R.A. from Greenwich Clock star list for 1887.	Tabular R.A. from *Berliner Jahrbuch* for 1887.
	h m s	h m s	h m s	h m s
Polaris	1 17 21·60	1 17 19·63	1 17 20·00	1 17 21·73
Cephei 51 (Hev.)	6 47 16·48	6 47 16·60	6 47 16·57	6 47 16·96
δ Ursæ Minoris	18 8 45·86	18 8 46·00	18 8 46·00	18 8 45·98
λ Ursæ Minoris	19 36 47·82	19 36 46·88	19 36 47·72	19 36 48·00

Radcliffe Observatory, Oxford:
1887, *January* 13.

Note on the Application of Photography to the Determination of Stellar Parallax. By the Rev. Prof. Pritchard, D.D., F.R.S.

At the meeting of the Society in June last, I communicated the results of some preliminary trials with the view of ascertaining the applicability of photography to astronomical measurements of sufficient delicacy for the accurate determination of stellar parallax.

These results proving eminently satisfactory, the requisite operations for the determination of parallax commenced on May 26 of last year by taking photographs of the district round 61^1 and 61^2 *Cygni*, which star was selected on account of the unusually numerous examinations which had been applied to it by successive astronomers from the time of Bessel (1840) to the present date; my object being not so much to effect a redetermination of the parallax of this historical star as to obtain the means of comparing the photographic method with those other methods of micrometrical measurement heretofore directly applied to this end.

For the purpose in view, four faint stars, viz.:

D.M. +37° No. 4189 . . . . (*a*)
D.M. +38 „ 4336 . . . . (*b*)
D.M. +37 „ 4175 . . . . (*c*)
D.M. +38 „ 4348 . . . . (*d*)

were selected from others whose images were impressed on the photographic plates. The distances of each of these four stars (eight in all) were carefully measured from each of the two components of 61 *Cygni*, on plates taken on fifty nights, ending on Dec. 7, 1886. In general, four plates were exposed each night, so that some 200 plates have been measured in the course

of the investigation. All these measures were strictly independent of each other, as were also the ultimate reductions. The astronomical importance and novelty of the inquiry seem to me to justify all this expenditure of time and labour.

In order to meet the ever-varying conditions of the instrument in respect of focus, and other contingent elements, the above measures were not reduced in terms of the registered scale of the macro-micrometer; but they were always referred to the presumably constant distance of the star (*a*) from the star (*b*), or of (*c*) from (*d*). These fundamental distances were always measured at the same time as were the other eight.

The proper motion of 61 *Cygni* has been so exactly determined that its effects could be definitively removed from the measured distances, and a temporary solution of the equations on this hypothesis appeared to be desirable and legitimate. The results of this preliminary solution are given as follows:—

	Star's Designation.	Parallax of 61^1 Cygni.	Probable Error.	Parallax of 61^2 Cygni.	Probable Error.
a	D.M. + 37 No. 4189	0·4412	0·0154	0·4204	0·0229
b	D.M. + 38 „ 4336	·4529	·0330	·4139	·0185
c	D.M. + 37 „ 4175	·4433	·0197	·4721	·0215
d	D.M. + 38 „ 4348	·4158	·0161	·4574	·0252

The provisional *means* for parallaxes thus obtained for the four independent sets of measures of 61^1 and 61^2 *Cygni* respectively are as follows: —

For 61^1 Cygni . . . . Parallax = $0''\cdot438$

61^2 Cygni . . . . Parallax = $0''\cdot441$

Values of the parallax of 61 *Cygni* have been determined by several astronomers; among them are found

Bessel $0''\cdot348$ in 1840

Auwers 0·564 in 1863

Ball 0·468 in 1878

Asaph Hall 0·261 in 1880

The Oxford determination is to be regarded as provisional only; the research will be continued to the end of the annual cycle, and full details will be communicated at the earliest opportunity.

In the communication made to the Society in June last reference was made to the liability of the photographic film to be occasionally dislocated. The possibility of such an occurrence renders it advisable in all cases where reliable accuracy is sought to take photographs in duplicate at least. One of the causes of this liability has been traced to its origin in the mechanical

action of the *impact* of water on the film; which *impact* has been regarded as essential to the proper washing of the plate. I find that in the entire series of about 200 plates, seven have exhibited minute but noticeable traces of this dislocation; these have been rejected in the above investigation.

University Observatory, Oxford:
Jan. 13, 1887.

Photographs of Nebulæ in Orion and in the Pleiades.

By Isaac Roberts.

The accompanying photograph of nebulæ in *Orion* is enlarged five times from a negative which I took on November 30 last, between $4^h\ 13^m$ and $5^h\ 20^m$ sidereal time at Maghull. The exposure was intended to extend to two hours, but an accident stopped it after $1^h\ 7^m$, and clouds have prevented another photograph being taken since that date.

The photographic extensions of the nebulæ may be judged by comparing this photograph with that taken by Mr. Common, and referring to the included and surrounding stars in them respectively, as places from which to measure.

It will thus be seen that the dark space shown on Mr. Common's photograph between the small nebula (Herschel, No. 1185) and the Great Nebula, as well as the "fish mouth," are filled with dense nebulous matter, which also can clearly be traced between Declination $-5°\ 15'$ and $-6°\ 15'$. In Right Ascension it can be traced between $5^h\ 26^m$ and $5^h\ 29^m$—an area about seven times that covered by Mr. Common's photograph.

There is a large, dense, and characteristically marked nebula to the north (Herschel, No. 1180), and the photograph indicates very faint nebulosity stretching some distance between this and the Great Nebula, but hitherto, owing to continuous bad weather, there has been no opportunity for proving by a long exposure of plates that this nebula also forms a part of the Great Nebula. If this should be proved, and there is now reasonable ground for inference, then extensions of the nebula will be revealed to us on a scale still more vast than has hitherto been known.

In the accompanying print the central parts of the nebulæ are white, without any shading, but on the negatives, when they are examined by the eye or under a microscope, those parts are full of detail, and delicate, but dense, cloud-like, curdling masses. I hope that, some time before the close of this session, I may have clear sky to enable me to present to the Society photographic analyses of this nebula, which will show the appearances presented by it with different lengths of exposure.

This method will give a more accurate insight into its constitution, and will furnish more reliable means for detecting any

changes that may take place within it in future, than if I were to force out the details on a print from one dense negative. I already have some of the negatives which will be required in the demonstrations here proposed.*

Nebula in the Pleiades.

The accompanying photograph was taken on December 29 (last month), between sidereal time at Maghull $2^h\ 55^m$, and $6^h\ 1^m$. The actual time of the exposure of the plate was three hours.

In bringing before the Society the first and second of the series of photographs of these nebulæ, I stated that upon one of them there were traces of nebulosity which indicated that the principal stars in the *Pleiades* are involved, or are in alignment with one vast nebula, and this photograph seems to prove the correctness of the inference.

The nebula (I now venture to use the singular) is traceable from the north of *Asterope*, and extends southwards 1° 10′. It includes *Taygeta*, *Maia*, *Celœna*, *Electra*, *Alcyone*, *Merope*, and numerous other small stars within itself.

On the north side of *Alcyone* is a dense mass of light, with a dark space between it and the star. The negative shows that it is not due to the contiguous blister on the glass plate. The nebulosity round *Maia* is characterised by broad streamers stretching in northerly and southerly directions; whilst round *Merope* somewhat similar streamers have n.p. to s.f. directions.

From *Electra* stretches a pointed streamer, which can be traced as far as a line drawn from *Maia* to *Merope*, and a little distance further south is another streamer resembling a detached nebulous straight line. These, and many other points, will be clearly seen on examination of the photograph, but much more clearly are they shown on the negatives. These appearances are both new and unexpected, and it is essential that the evidence of their reality should be so clear that it cannot reasonably be doubted. To this end I have taken already six photographs on different dates. The first was on October 23, 1886, with an exposure of $1^h\ 29^m$, and that showed all the features which are indicated on the chart prepared by MM. Henry at the Paris Observatory, and, in addition, large extensions of nebulous matter round *Maia* and *Merope*.

The second photograph was taken on the following night, October 24, with an exposure of three hours, and it showed vast extensions of nebulous matter round, between, and beyond *Alcyone*, *Merope*, *Electra*, *Maia*, *Taygeta*, *Asterope*, and other smaller stars.

These photographs were presented to the Society in November. On October 25, and December 16 and 24, I obtained one negative each night, but the sky was more or less misty, and at

* The short lines upon the photograph were caused by an accidental momentary movement of the instrument during the exposure of the plate.

times cloudy, during the exposure on each occasion, and consequently the nebulæ are not well developed, but what is shown confirms the features on the other negatives.

On December 29 I obtained the sixth negative, an enlargement of which I now present to the Society, and have already given in these notes a brief description of its general appearance.

The photographs are placed in the Library.

A New Variable Star in Puppis. By A. Stanley Williams.

The variability of the star L. 3105 in *Puppis* does not seem to have attracted attention hitherto. Whilst in southern latitudes last winter, I paid considerable attention to the magnitudes of the stars, and on February 17, 1886, noticed it as being exactly equal in brightness to the neighbouring star L. 3069. Upon referring to some previous determinations of magnitude I found that it had been rated both brighter and fainter than this star, and as these two stars had always been observed for magnitude at the same time, there seemed to be a reasonable suspicion that one or other of them was variable, and they were consequently kept under examination. Further observations soon showed that this suspicion was correct, and that L. 3105 is the variable star. The following table gives all the determinations of magnitude of these two stars which I was able to obtain.

Date. 1885.	Estimated Mags. L. 3069.	L. 3105.	Remarks.
Nov. 14	5·05	5·4	
21	4·7	4·4	
1886.			
Feb. 12	4·7	4·55	L. 3105 distinctly a little brighter than L. 3069.
17	4·5	4·5	The two stars exactly equal.
21	4·7	4·7	Equal.
Mar. 16	4·7	4·9	L. 3069 distinctly a little brighter than L. 3105.
21	4·8	5·2	L. 3069 *distinctly* and *considerably* brighter than L. 3105.
22	4·9	4·7	L. 3105 distinctly brighter than L. 3069.
30	5·2	5·4	The relative brightness probably more exactly estimated than the actual determinations of brightness, the stars being very low. Two or three days previous L. 3069 was seen distinctly superior to L. 3105, but the date was not registered.

The results are clearly not sufficiently numerous to indicate in a satisfactory manner the period of variation. This, however, is probably short, and if the differences between the brightness of the two stars L. 3069 and L. 3105 are chiefly considered, the observations are all well represented by a period of about 4·2 days; the probable extent of the variation being about ·7 of a magnitude. The star L. 3105 must have been near a maximum on November 21, 1885, and again on March 22, 1886, but not so near; and near a minimum on March 21, 1886.

The colour of the new variable was noted as "orange yellow" on February 12, 1886. The magnitudes both of this and L. 3069 are given as 5·0 in the *Uranometria Argentina*; Lacaille made them 6 mag., and in the Brisbane Catalogue they are also put at this figure. Behrmann's estimations are $5\frac{1}{3}$ mag. for L. 3069, and 5 mag. for L. 3105. The estimations of brightness given above were made by means of an opera-glass accurately focussed; the comparison stars were as under, the magnitudes being assumed from the "Harvard Photometry":—

ι Canis Majoris	=4·5 mag.
μ „	„ =5·2 „
17 „	„ =5·9 „
HP. 1342 „	„ =6·1 „

The position of L. 3105 for 1887·0 is R.A. $7^h\ 55^m\ 0^s$, Dec. S. 48° 55′·4.

West Brighton: Dec. 28, 1886.

On the Variability of the Spectrum of γ Cassiopeiæ.

By Ralph Copeland, Ph.D.

On page 16 of the current volume of the *Monthly Notices*, Mr. O. T. Sherman quotes a passage from Miss Clerke's "History of Astronomy during the Nineteenth Century," which says that the brilliant rays indicative of hydrogen in the spectrum of *γ Cassiopeiæ* died out during the nine years, 1874–1883. As to the fading of the rays there is room for little doubt, but the epochs of their disappearance and reappearance seem unfortunately quite indeterminate. Possibly the lines appear and vanish at comparatively short intervals, for there are two records of their having been seen here nearly in the middle of the nine years mentioned above. The most precise observation was made on Dec. 20, 1879, when testing a large experimental spectroscope which separated the D lines in the Moon's spectrum, and also showed four lines in that of the Great Nebula in *Orion* on the same night. The bright C line was then noted as "superbly

visible" by Lord Crawford (then Lord Lindsay), Mr. J. G. Lohse, and the writer. There is also a record of *two* bright lines having been seen by me on October 28, 1877, one of which was "well seen" about the place of F, the other being referred to about 477^{mmm} of wave-length, and described as "another bright line" without further remark. No mention is made of C on this occasion. At present, however, January 11, 1887, C is extremely bright; and as it was not visible at Bothkamp on June 18, 1872, although the red end of the spectrum was specially examined and the position of the bright F determined, there cannot be the slightest doubt as to the variability of the spectrum, as pointed out by M. von Gothard several years ago.

It is very remarkable that the C line is obviously more variable than F* in the spectrum of this most interesting star; this must necessarily involve a certain amount of colour change, which may partly explain the very conflicting evidence respecting the star's variability.

Lord Crawford's Observatory,
Dun Echt: Jan. 12, 1887.

Spectroscopic Observations of the Motion of Stars in the Line of Sight, made at the Temple Observatory, Rugby. By Geo. M. Seabroke.

In the year 1879 I brought before the notice of the Society some, perhaps rather premature, results of my spectroscopic observations of the motions of stars towards or away from our system. Since that time I have been engaged, whenever a sufficiently long period without interruption could be obtained, in continuing this line of research.

A large number of my observations have been made with a view to perfecting instrumental arrangements, and being, of course, otherwise valueless, are not recorded.

The following arrangement appears at present to be satisfactory, and with it the results detailed below have been obtained.

The telescope is a silver-on-glass Newtonian Reflector of $12\frac{1}{8}$ inches aperture, and 6 feet 6 inches in focal length, equatorially mounted. The spectroscope has a collimator of a focal length of 12 inches and $\frac{3}{4}$-inch aperture, and a Barlow lens in the telescope elongates the cone of rays to fit the same; a cylindrical lens is also used to give sufficient width of spectrum. The prisms are used twice, the rays of light passing first through the lower portions, and back through the upper portions to the observing

* The variability of the F-line was, however, remarked at Greenwich, on September 4, 1884, and may be generally inferred from its varying appearance on several other occasions.

telescope of 1 foot focal length, carrying an eyepiece which magnifies the slit about 15 times. The number of prisms used is equivalent to either 3 or 5 of 60°.

For comparison of the positions of the lines observed, I use a spot of light, or "ghost," produced by the reflection from the surface of the last prism of the rays of light proceeding from a minute slit carried by a micrometer, after passing through a collimating lens. The slit in question is illuminated by rays from a lamp carried on the large telescope, reflected from a silvered glass attached to the micrometer; the light is passed through a glass of a colour as near as possible that of the part of the spectrum under examination, so as to avoid want of focal coincidence.

The vacuum tube, or magnesium wire, is carried in front of the slit, and can be moved to and from that position at pleasure.

To compare the lines, the slit of the spectroscope is illuminated by the star and comparison lights alternately, and a reading of position of each taken with the ghost. The value of the divisions of the micrometer screw are ascertained by measurement of known lines on the solar spectrum.

For these observations the telescope at my disposal is very small, and therefore it is only the spectrum of the brighter stars that I am able to attack. There is a fine field in this line of research open to the possessors of large telescopes giving good definition.

In the following list of measures the sign + means that the star is receding from, and − approaching, our system. The corrected motion is the apparent value corrected for the orbital motion of the earth.

Number of Prisms.	Line Compared.	Number of Measures.	Cor. Motion in Miles per Second.	Date 1800+	Remarks.
			α Andromedæ.		
5	F	6	−22·5	85·87	
5	F	4	−29·2	·90	
			γ Pegasi.		
5	F	5	+13·6	85·87	Very difficult.
5	F	4	−66·8	·90	
			α Aurigæ.		
5	F	2	−41·5	86·27	Doubtful.
5	F	5	+15·1	·32	
5	F	3	+ 8·0	·33	
5	F	3	+ 8·5	·34	
			γ Geminorum.		
5	F	3	−46·3	85·19	

Number of Prisms.	Line Compared.	Number of Measures.	Cor. Motion in Miles per Second.	Date 1800+	Remarks.
			Sirius.		
5	F	4	−31·72	86·12	
5	F	9	−43·6	·16	
5	F	7	−49·5	·17	
			Castor.		
7	F	3	+19·6	82·30	
			Procyon.		
7	F	5	+15·8	85·19	
5	F	6	+ 7·5	86·17	
			Pollux.		
7	F	2	−34·4		
			α Leonis.		
7	F	5	+32·1	82·30	
7	F	3	+34·0	·35	
5	F	4	− 0·1	85·35	
5	F	3	− 3·5	86·33	
5	F	4	+52·5	·40	
			γ Leonis.		
5	F	2	+12·2	79·33	
7	F	3	+23·2	82·35	
7	F	2	−48·5	·36	
5	F	4	+ 7·2	85·35	
5	F	2	+21·3	·41	
5	F	2	−31·5	86·34	
5	F	2	−31·5	·40	
			α Ursæ Maj.		
5	F	3	− 0·5	85·42	
5	F	4	−11·2	86·42	
5	F	2	+22	·49	
5	F	3	+21·5	·54	
			γ Ursæ Maj.		
5	F	3	−24·9	85·42	
5	F	4	− 6·5	86·40	
5	F	4	−24·9	·49	

Number of Prisms.	Line Compared.	Number of Measures.	Cor. Motion in Miles per Second.	Date 1800+	Remarks.
			β Ursæ Maj.		
5	F	5	−58·7	85·42	
5	F	3	+11·6	86·49	
5	F	3	−50·0	·49	Very doubtful.
5	F	4	+27·2	·54	Line wide.
			δ Leonis.		
7	F	5	−42·4	82·36	
7	F	5	+39·0	·36	
5	F	7	−44·5	85·35	
5	F	4	−47·0	·41	
5	F	3	+32·0	86·40	
5	F	4	+ 7·0	·40	
			θ Leonis.		
7	F	4	+21·5	82·36	
7	F	8	+33·8	·36	
5	F	4	+ 8·2	85·35	
5	F	5	+43·3	·41	
5	F	4	+32·5	86·40	
5	F	4	−31·5	·40	
			β Leonis.		
5	F	4	+14·5	85·35	
5	F	5	+23·8	·41	
5	F	4	−53·0	86·34	
5	F	3	+ 5·0	·40	
5	F	3	−24·5	·40	
			δ Ursæ Maj.		
5	F	3	−31·6	85·42	
5	F	2	−16·4	·48	
5	F	3	+20·4	86·49	
5	F	1	+36·0	·54	
			ζ Virginis.		
5	F	1	−43·0	85·41	Doubtful.
			ε Ursæ Maj.		
5	F	3	−29·3	85·41	
5	F	6	−61·3	·48	
5	F	9	−52·2	86·49	
5	F	6	−69·9	·50	

Number of Prisms.	Line Compared.	Number of Measures.	Cor. Motion in Miles per Second.	Date 1800+	Remarks.
			ζ Ursæ Maj.		
5	F	3	−23·5	85·41	
5	F	3	−48·0	·45	
5	F	5	+20·1	·48	
5	F	4	+14·4	86·50	
5	F	4	− 2·6	·54	
5	F	3	−10·4	·64	
5	F	3	+29·5	·66	
5	F	5	+25·0	·69	
5		2	+15·5	·70	
			α Virginis.		
7	F	7	+16·9	82·36	Difficult.
7	F	7	+13·5	·36	
5	F	7	+ 3·7	85·41	
5	F	4	+43·2	·41	
			η Bootis.		
7	F	6	+ 5·9	82·37	
5	F	3	−40·1	86·50	
5	F	5	− 8·5	·54	
			η Ursæ Maj.		
5	F	5	+25·0	86·50	
5	F	5	−11·1	·54	
5	F	5	+10·0	·64	
5	F	4	+ 8·6	·66	
5	F	7	+26·5	·69	
5	F	3	+24·0	·70	
5	F	3	+18·9	·70	
			Arcturus.		
7	F	4	+24·1	82·37	
5	F	5	+13·2	85·41	
5	F	3	−76·6	·44	
5	F	5	−24·1	·45	
5	F	3	−44·1	·48	
5	F	4	−18·2	·48	
5	F	3	+14·6	·51	
5	F	4	−40·1	·55	

Number of Prisms.	Line Compared.	Number of Measures.	Cor. Motion in Miles per Second.	Date 1800+	Remarks.
			Arcturus.		
5	F	3	+ 3·0	86·49	
5	F	4	−43·0	·64	
5	F	3	−29·0	·66	
5	F	2	−36·0	·69	
			ε Bootis.		
5	F	4	−16·7	85·55	
5	F	3	−29·3	86·50	
5	F	1	+ 8·0	·66	
5	F	3	+ 2·0	·69	
5	F	4	−36·4	·74	
			α Coronæ Bor.		
5	F	3	−36·5	86·64	
5	F	3	+13·9	·64	
5	F	1	−33·0	·66	
5	F	3	−45·0	·69	
5	F	4	−27·5	·70	
			α Ophiuchi.		
5	F	4	−21·3	85·51	
5	F	4	−55·4	·75	
5	F	5	− 1·4	86·64	
5	F	4	−23·1	·66	
5	F	2	+ 7·0	·69	
5	F	2	−24·5	·69	
			Vega.		
7	F	3	−65	81·53	
7	F	3	−45·9	·73	
5	F	2	−28·9	85·48	
5	F	4	−59·2	·50	
5	F	8	−43·3	·71	
5	F	3	−49·2	·74	
5	F	2	−41·5	86·69	
5	F	3	−32·4	·70	
5	F	4	−32·9	·72	

Number of Prisms.	Line Compared.	Number of Measures.	Cor. Motion in Miles per Second.	Date 1800+	Remarks.
			γ Lyræ.		
5	F	4	+11·5	86·74	Very faint.
3	F	6	−44·6	·75	
3	F	4	−35·7	·87	
3	F	2	−66·0	·88	
			ζ Aquilæ.		
5	F	10	−29·5	85·75	
5	F	4	−177·3	·78	
5	F	5	−30·0	86·72	
3	F	5	+14·0	·75	
			γ Aquilæ.		
5	F		−31·9	86·72	
3	F		+34·4	·75	
3	F	est.	−30·0	·87	
			δ Cygni.		
7	F	2	−26·5	81·74	
7	F	3	−55·6	·79	
5	F	6	+24·6	85·72	
5	F	4	− 5·8	·75	
5	F	4	−15·7	·75	
5	F	4	+38·1	·78	
5	F	2	−36 9	·87	
3	F	5	−63·5	86·80	
3	F	4	−50·7	·88	
3	F	3	−50·2	·91	
			Altair.		
5	F	3	+22·7	84·70	
5	F	4	−38·6	·77	
5	F	2	−43·6	85·74	
5	F	4	+ 6·0	·75	
5	F	7	−19·4	·75	
5	F	5	−25·1	·78	
5	F	3	−22·0	86·64	
5	F	7	− 0·4	·72	
5	F	4	− 2·8	·74	
3	F	4	−70·0	·88	

Number of Prisms.	Line Compared.	Number of Measures.	Cor. Motion in Miles per Second.	Date 1800+	Remarks.
			γ Cygni.		
7	F	5	−68·0	81·79	
5	F	4	−46·3	85·75	
5	F	5	+33·2	·90	
3	F	4	−57·0	86·80	
3	F	3	−57·5	·88	
3	F	3	−66·0	·91	
			α Cygni.		
7	F	2	+31·0	81·73	
7	F	3	−32·8	·78	
7	F	3	+29·9	·79	
7	F	7	−35·5	·79	
5	F	6	−22·5	86·69	
5	F	3	+18·5	·69	
3	F	5	−34·0	·80	
3	F	5	−18·6	·91	
			ε Cygni.		
7	F	2	−53·4	81·79	Uncertain.
5	F	4	−21·7	85·87	
3	F	2	−63·0	86·80	
3	F	1	−59·0	·91	
			η Pegasi.		
5	F	4	−54·4	85·8	
			α Pegasi.		
6	F	4	− 0·2	80·88	
7	F	2	−39·5	81·79	
5	F	4	−44·6	85·87	
5	F	6	−41·6	·87	
5	F	5	−21·9	·90	
			β Pegasi.		
5	F	1	+ 1·8	85·87	

Spectroscopic Results for the Motions of Stars in the Line of Sight, obtained at the Royal Observatory, Greenwich, in the year 1886. No. X.

(*Communicated by the Astronomer Royal.*)

The results here given are in continuation of those printed in the *Monthly Notices*, vol. xxxvi. p. 318, vol. xxxvii. p. 22, vol. xxxviii. p. 493, vol. xli. p. 109, vol. xlii. p. 230, vol. xliii. p. 81, vol. xliv. p. 89, vol. xlv. p. 330, and vol. xlvi. p. 126. The observations were made with the "half-prism" spectroscope, one "half-prism" with a dispersion of about $18\frac{1}{2}°$ from A to H being used throughout. Eyepieces with magnifying powers of 14 and 22 respectively were employed.

The cylindrical lens has always been used in front of the slit as in the observations made previously to 1881. The observations of the Moon and of the sky have been made as a check on the general accuracy of the results.

The day specified in the first column is the Civil Day, and the hour is that of Greenwich Civil Time, commencing at Greenwich Mean Midnight, and reckoning from 0 to 24 hours.

Motions of Stars in the Line of Sight, in Miles per Second, observed with the Half-prism Spectroscope.

(+ denotes Recession; − Approach.)

The initials M., N., and L. are those of Mr. Maunder, Mr. Nash, and Mr. Lewis respectively.

Date. 1886.	h	Obs.	No. of Meas.	Line.	Earth's Motion in miles per sec.	Concluded Motion of Star. Meas.	Estimd.	Remarks.
					α Andromedæ.			
Jan. 27	19	M	2	F	+15·4	−26·4	−23·6	Spectrum fairly steady.
Feb. 1	19	M	2	F	+14·7	−75·3	−44·2	Definition poor.
Nov. 5	23	M	2	F	+ 8·6	(− 2·0)	(+ 2·5)	Spectroscope out of adjustment.
					γ Pegasi.			
Feb. 1	19	M	2	F	+15·0	− 6·5	− 5·7	Definition bad; star-line seen with great difficulty.
					β Arietis.			
Feb. 1	19	M	2	F	+18·4	−85·4	−45·5	Definition very bad.
Dec. 4	21	M	4	F	+12·1	+12·4	+11·8	Definition good.
					β Persei.			
Jan. 27	20	M	2	F	+16·8	−50·2	−46·4	Definition fair.
Feb. 1	20	M	2	F	+17·1	−28·6	−30·7	Wind high but definition fair.

Date. 1886.	h	Obs.	No. of Meas.	Line.	Earth's Motion in miles per sec.	Concluded Motion of Star. Meas.	Concluded Motion of Star. Estimd.	Remarks.
					β Persei.			
Nov. 29	20	M	6	F	+ 3·9	+ 4·3	+ 2·1	Definition good.
Dec. 4	22	M	4	F	+ 5·4	−111·8	−106·4	Spectrum faint; definition poor.
14	20	M	5	F	+ 8·3	+12·2	+13·6	Definition fair.
14	20	L	5	F	+ 8·3	− 3·4	+12·1	Definition fair.
					α Persei.			
Jan. 27	20	M	2	F	+15·1	−40·9	−34·8	Definition fair.
Feb. 1	20	M	2	F	+15·6	−21·2	−25·7	Wind very high; definition poor.
Nov. 29	21	M	2	F	+ 2·0	+ 6·8	+ 7·6	Star-line faint.
Dec. 4	23	M	2	F	+ 3·5	−10·4	− 7·6	Definition good.
					Aldebaran.			
Jan. 27	20	M	2	F	+16·3	+22·9	+ 8·3	
Mar. 3	21	M	2	F	+18·5	+24·8	+13·4	Definition poor.
17	20	M	2	b_1	+17·4	+13·6	+24·9	Definition poor.
Nov. 17	23	M	4	F	− 4·1	+44·3	+40·0	Star-line faint.
29	22	M	2	F	− 0·2	+18·9	+18·2	Definition poor.
Dec. 4	23	M	2	F	+ 1·5	+41·5	+43·0	Definition fair.
					Capella.			
Jan. 27	22	M	4	F	+12·9	− 4·0	− 3·9	Star-line very well seen.
Mar. 3	21	M	2	F	+17·1	−54·5	−52·5	Definition fair.
17	20	M	2	b_1	+16·9	+42·3	+46·6	Star-line faint.
23	21	N	2	b_1	+16·6	−20·8	−16·6	Spectrum tremulous; star-line faint.
Apr. 6	22	N	2	F	+15·1	+ 1·5	− 0·4	Spectrum tremulous.
Nov. 29	22	M	2	F	− 3·8	+29·5	+30·2	Star-line faint.
					Rigel.			
Jan. 27	21	M	2	F	+12·9	+30·6	+17·8	Star-line fairly well seen.
Feb. 1	20	M	2	F	+13·7	+ 5·5	+ 0·3	Wind *very* high; star-line seen with great difficulty.
Mar. 3	20	M	2	F	+16·0	+19·4	+ 8·8	Definition poor; measures rough.
Nov. 5	23	M	2	F	− 8·4	(+58·5)	(+61·6)	Spectroscope out of adjustment.
18	0	M	2	F	− 5·4	+ 9·8	+ 9·6	Star-line distinct and well-defined.
					γ Orionis.			
Jan. 27	21	M	2	F	+13·6	+ 4·9	− 2·7	Star-line very well seen.
Feb. 1	20	M	2	F	+14·6	− 1·3	− 4·0	Wind very high; star-line seen with great difficulty.

Date. 1886.	h	Obs.	No. of Meas.	Line.	Earth's Motion in miles per sec.	Concluded Motion of Star. Meas.	Estimd.	Remarks.
					γ Orionis.			
Mar. 3	20	M	2	F	+17·8	+ 6·3	+ 0·6	Star-line seen with great difficulty.
Nov. 18	1	M	4	F	− 7·2	+11·5	+11·6	Spectrum fairly bright and steady.
					β Tauri.			
Jan. 27	21	M	2	F	+13·8	−38·0	−37·9	Star-line fairly well seen.
Feb. 1	21	M	2	F	+14·8	−25·4	−25·3	Wind very high. Definition bad.
Mar. 3	20	M	4	F	+18·4	−31·5	−35·1	Definition poor.
Nov. 18	1	M	2	F	− 8·0	− 8·0	− 8·1	Star-line well seen.
					δ Orionis.			
Jan. 27	21	M	2	F	+12·7	+ 7·8	+ 3·8	Spectrum rather faint and tremulous.
					ε Orionis.			
Jan. 27	21	M	2	F	+12·4	+14·8	+ 7·3	Spectrum rather faint and tremulous.
					ζ Orionis.			
Jan. 27	21	M	2	F	+12·1	+13·2	+14·2	Spectrum rather faint and tremulous.
					κ Orionis.			
Jan. 27	21	M	2	F	+10·9	−21·4	−19·1	Star-line fairly well seen.
					α Orionis.			
Mar. 17	21	M	2	b_4	+17·8	+34·0	+39·4	Definition fair.
					β Aurigæ.			
Jan. 27	22	M	2	F	+11·3	−35·5	−40·9	Spectrum rather faint and tremulous.
Mar. 3	21	M	2	F	+16·8	−58·7	−55·1	Definition fair.
					γ Geminorum.			
Jan. 27	22	M	6	F	+ 9·5	−48·1	−40·7	Spectrum bright and steady, but star-line exceedingly broad and diffused and difficult to bisect.
Feb. 1	21	M	2	F	+10·9	−43·7	−34·2	Wind very high; definition bad.
					Sirius.			
Jan. 19	22	M	2	F	+ 4·4	−13·7	−13·1	Spectrum very tremulous.
27	22	M	6	F	+ 6·3	−32·6	−32·2	
Mar. 3	22	M		F	+12·6	−38·6	−35·7	Definition bad. Star in light cloud.
Nov. 5	1	M	4	F	−12·3	(+31·0)	(+32·3)	Spectroscope out of adjustment.
18	2	M	6	F	−10·6	+ 8·4	+ 8·3	Star-line well seen.

Date. 1886.	h	Obs.	No. of Meas.	Line.	Earth's Motion in miles per sec.	Concluded Motion of Star. Meas.	Estimd.	Remarks.
					Castor.			
Jan. 27	23	M	2	F	+ 6·2	+29·2	+32·1	Spectrum tremulous; star-line very ill-defined.
Apr. 6	23	N	4	F	+18·0	−14·9	−15·8	Star-line ill defined.
May 1	22	M	2	F	+16·4	+24·7	+13·0	Definition good.
Nov. 18	2	M	2	F	−14·7	+27·8	+27·2	Star-line well seen.
					Procyon.			
Jan. 18	23	N	3	F	+ 1·5	+ 0·3	− 1·5	Spectrum bright; definition fair.
27	23	M	6	F	+ 4·4	−13·8	−13·5	Spectrum bright; definition good.
28	22	N	1	F	+ 4·7	− 4·1	− 4·7	
Mar. 3	22	M	4	F	+13·6	−38·8	−41·3	
Apr. 6	22	N	2	F	+17·5	−21·5	−21·9	
May 1	21	M	2	F	+16·6	−57·9	−41·3	Definition bad; measures very rough.
Nov. 18	2	M	4	F	−15·4	+ 9·5	+ 9·8	Star-line well seen.
					Pollux.			
Jan. 27	23	M	2	F	+ 5·3	−45·1	−51·8	Definition good.
Mar. 17	22	M	2	b_1	+16·8	−29·4	−39·0	Star-line difficult to see.
23	23	N	2	b_1	+17·4	−24·3	−23·8	Measures rendered difficult by mist.
Apr. 6	23	N	2	F	+18·1	−30·5	−29·9	Spectrum tremulous; star-line faint.
May 1	22	M	2	F	+16·9	−45·8	−45·1	Measures made with great difficulty.
Nov. 18	2	M	2	F	−15·5	−15·5	−12·3	Star-line fairly well seen at times.
					Regulus.			
Apr. 30	22	N	2	F	+17·2	−17·2	−17·2	
May 3	23	M	2	F	+17·5	+ 1·8	+ 4·7	Spectrum bright; definition fair.
6	23	N	2	F	+17·6	−14·3	−13·4	Measures made with difficulty.
15	21	M	2	F	+17·9	− 5·2	− 3·4	Star-line very ill-defined.
18	23	N	2	F	+17·9	− 3·0	− 2·9	Star-line diffused and faint.
					β Ursæ Majoris.			
May 1	23	M	2	F	+12·7	+ 5·7	− 2·0	Spectrum faint; measures rough.
					α Ursæ Majoris.			
May 1	23	M	2	F	+11·7	−59·7	−52·7	Star-line very difficult to see.
June 16	1	N	2	b_1	+ 8·7	−57·3	−57·5	

Date. 1886.	h	Obs.	No. of Meas.	Linc.	Earth's Motion in miles per sec.	Concluded Motion of Star. Meas.	Estimd.	Remarks.
					δ Leonis.			
May 15	22	M	2	F	+16·8	−44·0	−50·1	Definition fair.
					β Leonis.			
Apr. 30	23	N	2	F	+13·6	−30·5	−30·3	
May 4	1	M	2	F	+14·2	−10 9	−10·5	Spectrum fairly bright and steady.
15	22	M	2	F	+15·9	−14·7	−13·8	Definition fair.
					γ Ursæ Majoris.			
May 1	23	M	2	F	+11·7	+ 1·2	+ 0·8	Star-line very ill-defined.
June 16	0	N	2	b_1	+10·9	− 2·9	− 2·8	Spectrum faint, but star-line seen well at times.
					γ Virginis.			
May 4	1	M	2	F	+10·3	−43·6	−41·1	Spectrum fairly bright and steady.
					ε Ursæ Majoris.			
May 1	23	M	2	F	+ 9·5	− 5·1	− 3·0	Star-line very ill-defined.
					α Canum Venaticorum.			
May 13	22	M	2	F	+11·9	−35·6	−36·8	Spectrum steady, but definition poor.
					Spica.			
Apr. 30	23	N	2	F	+ 5·7	−16·5	−15·7	
May 4	1	M	2	F	+ 6·6	−60·8	−53·4	Spectrum very tremulous.
18	23	N	2	F	+10·5	− 7·4	− 6·4	Definition poor; measures rough.
					ζ Ursæ Majoris.			
May 2	0	M	2	F	+ 8·4	+ 6·5	+ 7·0	Definition fair.
					Arcturus.			
Apr. 30	23	N	2	F	+ 4·8	−21·0	−21·5	
May 4	2	M	2	F	+ 5·5	−71·3	−64·6	Spectrum bright; definition good.
6	23	N	2	F	+ 6·2	−23·7	−23·9	
13	22	M	2	F	+ 7·8	−35·0	−39·4	Spectrum bright, but definition poor.
18	23	N	2	F	+ 8·9	−35·0	−33·5	
20	22	N	2	F	+ 9·3	−26·5	−27·8	Star-line very indistinct.

Date. 1886.	h	Obs.	No. of Meas.	Line.	Earth's Motion in miles per sec.	Concluded Motion of Star. Meas.	Estimd.	Remarks.
					Arcturus.			
June 7	22	M	2	b_1	+12·5	−49·1	−46·9	Spectrum and star-lines rather faint.
15	23	N	2	b_1	+13·5	−57·3	−54·2	
28	23	M	2	b_1	+14·7	−37·8	−38·7	Definition poor.
July 5	23	M	2	F	+15·1	−36·8	−38·9	Star-line seen fairly well at times.
					ϵ^2 *Bootis.*			
June 28	23	M	2	F	+12·7	−15·0	−10·4	Definition bad.
					β Libræ.			
May 13	23	M	2	F	+ 1·7	−24·8	−23·3	Spectrum bright, but tremulous.
					α Coronæ Borealis.			
May 4	2	M	4	F	+ 0·7	−26·6	−23·8	Star-line very difficult to bisect.
14	0	M	2	F	+ 2·8	+12·8	+19·6	Spectrum bright; definition fair.
20	23	N	2	F	+ 4·2	−16·2	−15·0	
July 5	23	M	2	F	+11·4	+24·3	+24·3	Definition fair.
					α Serpentis.			
June 29	0	M	2	b_1	+11·7	− 4·0	− 1·5	Star-lines very faint; definition poor.
					β Serpentis.			
May 14	0	M	2	F	+ 1·3	−14·2	−16·2	Star-line well seen.
					γ Herculis.			
May 14	1	M	1	F	− 1·1	−36·9	−38·8	Observation interrupted by cloud.
					α Ophiuchi.			
July 5	23	M	2	F	+ 5·7	−19·7	−19·6	Definition fair.
					γ Draconis.			
June 29	1	M	2	b_1	+ 0·9	+20·9	+33·7	Definition bad; star-lines seen with great difficulty.
					Vega.			
July 6	0	M	2	F	+ 0·0	−12·9	−11·9	Definition fair.
Aug. 10	23	N	2	F	+ 4·8	−29·7	−31·3	Spectrum bright and steady; definition good.

Date. 1886.		Obs.	No. of Meas.	Line.	Earth's Motion in miles per sec.	Concluded Motion of Star. Meas.	Estimd.	Remarks.
					Vega.			
Oct.	13 h 20	M	2	F	+ 8·7	−60·8	−48·6	Observations interrupted by cloud.
	22 19	M	2	F	+ 8·5	−58·6	−44·8	Spectrum bright and steady.
					Altair.			
July	6 1	M	2	F	− 4·3	−23·7	−21·5	Definition fair.
Aug.	10 23	N	2	F	+ 4·9	−31·2	−32·8	Star-line broad and diffused.
Oct.	18 22	M	2	F	+16·1	−67·6	−54·4	Spectrum very faint and tremulous.
	22 20	M	1	F	+16·2	−42·9	−38·5	Spectrum bright and fairly steady.
					γ Cygni.			
June	29 1	M	2	b_1	− 6·9	+ 9·9	+12·2	Definition very bad.
					α Cygni.			
June	29 2	M	2	b_1	− 7·4	+ 0·5	− 0·6	Definition bad; star-lines seen with great difficulty.
July	6 1	M	2	F	− 6·8	−22·1	−23·0	Definition fair.
Oct.	18 22	M	2	F	+ 7·3	−55·3	−45·6	Definition fair.
					α Pegasi.			
Jan.	27 19	M	4	F	+12·4	−34·4	−26·1	Measures made with great difficulty.
Feb.	1 19	M	2	F	+11·2	−35·8	−25·1	Definition bad; measures rough.
Aug.	11 1	N	2	F	− 9·3	+ 3·4	+ 5·4	Spectrum faint.
					Mars.			
Mar.	17 22	M	4	b_1		+10·8	+15·9	Definition fair; calculated motion +2·0.
	23 23	N	4	b_1		− 6·9	− 9·0	Planet-line faint; calculated motion +3·3.
Apr.	6 23	N	2	F		+ 2·3	+ 1·5	Calculated motion +5·6.
	22 23	N	1	F		+ 1·8	0·0	Calculated motion +7·3.
	30 22	N	2	F		+ 5·1	+ 4·0	Calculated motion +7·8.
May	4 0	M	4	F		− 7·2	− 7·4	Definition fair; calculated motion +8·0.
					Venus.			
Jan.	16 18	M	10	F		− 6·8	− 7·7	Computed motion −6·7.
	27 18	M	10	F		−13·6	− 7·6	Computed motion −5·4.

Moon.

Date.	h	Obs.	No. of Meas.	Line.	Motion Measured.	Remarks.
Jan. 18	23	N	4	F	+2·5	
Mar. 17	22	M	5	b_1	−0·1	
May 13	23	M	5	F	+0·2	
15	23	M	5	F	−1·1	The coincidence of the two spectra appeared perfect.
18	23	N	4	F	−1·5	
20	23	N	4	F	−4·6	
June 15	23	N	4	b_1	−5·4	
Aug. 10	23	N	5	F	−1·9	
Nov. 5	23	M	5	F	(+5·5)	The comparison was not quite satisfactory.
18	3	M	5	F	+0·3	The coincidence of the two spectra appeared perfect.
Dec. 4	22	M	5	F	+0·9	

Sky.

Jan. 28	12	M	5	F	+1·2	The coincidence of the two spectra appeared perfect.
Feb. 2	12	M	5	F	+3·2	
Mar. 4	12	M	5	F	−2·1	No want of coincidence could be detected.
24	12	N	3	F	−2·5	
May 3	10	M	5	F	−0·6	
June 8	10	M	5	b_1	+4·1	The coincidence of the two spectra appeared perfect.
29	12	M	5	b_1	−0·9	
July 6	13	M	5	F	+1·8	
Nov. 30	12	M	5	F	−2·0	No want of coincidence could be detected.

Rotation of Jupiter.

Displacement between the p and f limbs.

					$p-f$.	
May 15	23	M	5	F	+32·3	Position-angle of slit 26°. The mean point observed was about 0″·5 from the limb. Definition fair.

Computed relative motion of the limbs $p - f + 30{\cdot}9$ miles per second, the equatorial diameter of *Jupiter* being taken as 88,000 miles, and its period of rotation as $9^h\ 56^m$.

Observations of Occultations of Stars by the Moon, and of Phenomena of Jupiter's Satellites, made at the Royal Observatory, Greenwich, in the year 1886.

(*Communicated by the Astronomer Royal.*)

Occultations of Stars by the Moon.

Day of Obs.		Phenomenon.		Telescope.	Power.	Moon's Limb.	Mean Solar Time of Observation.	Observer.
							h m s	
1886, Jan.	14	Disapp.	Bradley 381	Altaz.	100	Dark	7 8 24·46	H.
	16	Reapp.	θ^2 Tauri	E. Eq.	70	Bright	4 56 18·41	H.
	16	,,	θ^2 Tauri	Simms' Eq.	220	,,	4 56 17·65	L.
	16	,,	θ^1 Tauri	E. Eq.	70	,,	4 57 59·03	H.
	16	Disapp.	Bradley 619	N. Eq.	80	Dark	4 58 15·31	C.
	16	,,	Aldebaran	N. Eq.	80	,,	7 47 37·09	C.
	16 (*a*)	,,	Aldebaran	S.E. Eq.	220	,,	7 47 36·03	M.
	16	,,	Aldebaran	Altaz.	100	,,	7 47 37·27	L.
	16	,,	Aldebaran	E. Eq.	70	,,	7 47 37·05	H.
	16 (*b*)	Reapp.	Aldebaran	N. Eq.	80	Bright	8 48 27·45	C.
	16 (*c*)	,,	Aldebaran	S.E. Eq.	220	,,	8 48 28·07	M.
	16 (*d*)	,,	Aldebaran	Altaz.	100	,,	8 48 28·23	L.
	16 (*e*)	,,	Aldebaran	E. Eq.	70	,,	8 48 (31·81)	H.
	18	Disapp.	26 Geminorum	E. Eq.	70	Dark	8 37 14·94	L.
	18	,,	26 Geminorum	Altaz.	100	,,	8 37 15·48	H.
Mar.	9 (*f*)	,,	ξ^1 Ceti	Lassell Refl.	130	,,	6 34 24·38	H. T.
	9	,,	ξ^1 Ceti	Altaz.	100	,,	6 34 23·77	A. D.
	9 (*g*)	,,	ξ^1 Ceti	E. Eq.	70	,,	6 34 24·33	L.
	9	Reapp.	Ceti	Simms' Eq.	80	Bright	7 39 27·58	H. T.
	9	,,	64 Ceti	E. Eq.	70	,,	6 38 3·23	L.

Day of Obs.	Phenomenon.		Telescope.	Power.	Moon's Limb.	Mean Solar Time of Observation. h m s	Observer.
1886, April 10	Disapp.	26 Geminorum	E. Eq.	210	Dark	10 24 13·83	L.
15	,,	τ Leonis	Altaz.	100	,,	9 20 42·17	H.
May 6	,,	111 Tauri	Altaz.	100	,,	8 11 2·18	L.
June 23	Reapp.	24 Piscium	Altaz.	100	,,	13 48 56·08	R.
Aug. 19	,,	ν Piscium	Altaz.	100	,,	11 47 50·56	R.
19	,,	ν Piscium	E. Eq.	70	,,	11 47 51·38	H. W.
Sept. 7	Disapp.	Brad. 2402	Altaz.	100	,,	9 43 1·55	A. D.
7	,,	Brad. 2402	E. Eq.	70	,,	9 43 1·77	H.
Oct. 22	Reapp.	44 Leonis	E. Eq.	70	,,	14 38 48·50	H. T.
22	,,	Piazzi X. 67	E. Eq.	70	,,	14 49 2·71	H. T.
Nov. 21 (*h*)	,,	46 Virginis	Altaz.	100	,,	17 31 21·05	L.
Dec. 3	Disapp.	h^1 Aquarii	Altaz.	100	,,	5 8 28·30	T.
3	,,	h^1 Aquarii	E. Eq.	70	,,	5 8 28·45	L.
3	,,	h^2 Aquarii	E. Eq.	70	,,	5 9 28·98	L.
3 (*i*)	,,	h^3 Aquarii	Lassell Refl.	170	,,	5 29 36·24	H. T.
10 (*j*)	,,	Bradley 686	Altaz.	100	,,	10 28 37·40	J. P.
18 (*k*)	Reapp.	γ^1 Virginis	Altaz.	100	,,	14 34 5·34	T.

Notes.

(*a*) Disappearance instantaneous.
(*b*) Reappearance did not seem to be quite instantaneous.
(*c*) The reappearance occupied a *minute* but perceptible interval, say ·2 of a second or less. The time recorded is that of the commencement of the reappearance.
(*d*) Star seemed to take about half a second to clear the Moon's limb; high wind.
(*e*) Observation not considered satisfactory, as high wind prevented the clock being heard distinctly.
(*f*) Star seemed to disappear instantaneously when well within the dark limb.
(*g*) The star at disappearance seemed to be well within the dark limb; the disappearance was instantaneous.
(*h*) Cloudy.
(*i*) Star appeared very faint before disappearance.
(*j*) Star faint.
(*k*) The observer could not see two stars close to limb at reappearance.

Day of Obs.	Satellite.	Phenomenon.		Telescope.	Power.	Mean Solar Time of Observation. h m s	Mean Solar Time of N.A. h m s	Observer.
1886, Feb. 22 (*a*)	I.	Ecl. D.	Began to fade	Altaz.	100	10 13 27	10 15 8	L.
22	I.		Last seen	„	„	10 15 8		„
23 (*b*)	I.	Tr. Egr.	Last contact	Simms' Eq.	220	10 17 21	10 16	H. T.
Mar. 8	II.	Ecl. D.	Last seen	E. Eq.	70	12 51 6	12 50 30	H.
9	I.	Tr. Ing.	First contact	„	210	11 29 18	11 31	L.
9	I.		Last contact	„	210	11 32 22		„
9 (*c*)	I.	Tr. Egr.	First contact	„	70	13 41 41	13 45	„
9	I.		Last contact	„	„	13 45 11		„
10	III.	Occ. R.	First seen	Simms' Eq.	80	9 52 22	9 58	H.
10 (*d*)	III.		Bisection	„	„	9 56 37		„
10	III.		Last contact	„	„	10 2 17		„
10	II.	Tr. Egr.	First contact	E. Eq.	210	10 41 30	10 49	T.
10	II.		Last contact	„	„	10 44 45		„
10	I.	Occ. R.	First seen	„	„	10 56 13	10 59	„
10	I.		Last contact	„	„	10 58 42		„
11	I.	Tr. Egr.	First contact	Simms' Eq.	140	8 8 16	8 11	L.
11	I.		Last contact	„	„	8 12 21		
11 (*e*)	IV.	Ecl. R.	First seen	„	220	12 35 35	12 28 45	H. T.
17	III.	Ecl. D.	Last seen	„	„	10 8 31	10 6 43	A. D.
17 (*f*)	II.	Tr. Ing.	First contact	„	„	10 12 31	10 16	„
17	II.	Tr. Ing.	Last contact	„	„	10 19 16		„

Day of Obs.		Satellite.	Phenomenon.		Telescope.	Power.	Mean Solar Time of Observation. h m s	Mean Solar Time of N.A. h m s	Observer.
1886, Apr.	1 (*g*)	I.	Tr. Ing.	Last contact	E. Eq.	210	11 10 28	11 9	H.
	3	I.	Tr. Egr.	First contact	Altaz.	100	7 45 34	7 50	T.
	3	I.		Last contact	,,	,,	7 48 48		,,
	8	I.	Tr. Ing.	First contact	,,	,,	12 50 39	12 54	,,
	8	I.		Last contact	,,	,,	12 55 9		,,
	9	I.	Occ. D.	Last seen	,,	,,	10 5 39	10 5	A. P.
	9	I.		Last seen	E. Eq.	210	10 5 14		S. D.
	9	II.		Last seen	Altaz.	100	11 39 54	11 39	A. P.
	9	II.		Last seen	E. Eq.	210	11 39 59		S. D.
	9 (*h*)	I.	Ecl. R.	First seen	Lassell Refl.	350	12 44 33	12 44 46	H. T.
	9	I.		First seen	Altaz.	100	12 44 43		S. D.
	11	II.	Tr. Egr.	First contact	E. Eq.	210	8 44 5	8 48	A. D.
	11	II.		Bisection	,,	,,	8 46 10		,,
	11	II.		Last contact	,,	,,	8 49 34		,,
	22	III.	Ecl. R.	First seen	,,	70	8 46 28	8 43 44	J. P.
	25 (*i*)	I.		First seen	Simms' Eq.	220	11 2 5	11 1 34	H. T.
	27	II.		First seen	E. Eq.	210	9 51 57	9 52	H.
	29	III.	Occ. R.	Bisection	Altaz.	100	9 23 53	9 23	R. W.
	29	III.		Last contact	,,	,,	9 26 13		,,
	29 (*j*)	III.	Ecl. D.	Began to fade	E. Eq.	210	9 57 24	9 59	A. D.
	29	III.		Last seen	,,	,,	10 3 7		,,
	29 (*k*)	III.	Ecl. R.	First seen	Simms' Eq.	220	12 41 32	12 41 19	H. T.

Day of Obs.	Satellite.	Phenomenon.		Telescope.	Power.	Mean Solar Time of Observation.	Mean Solar Time of N.A.	Observer.
						h m s	h m s	
1886, Apr. 30	IV.	Occ. D.	Bisection	Simms' Eq.	220	8 27 1	8 33	H.T.
30 (*l*)	IV.		Last seen	,,	,,	8 33 31		,,
30	IV.	Occ. R.	First seen	,,	,,	9 55 31		,,
30	IV.		Bisection	,,	,,	10 0 38		,,
30 (*m*)	IV.		Last contact	,,	,,	10 11 31	10 1	L.
30	IV.		First seen	E. Eq.	210	9 59 47		,,
30	IV.		Last contact	,,	,,	10 9 26		,,
May 2 (*n*)	I.	Ecl. R.	First seen	Lassell Refl.	350	12 56 0	12 55 53	H. T.
2	II.	Tr. Ing.	First contact	,,	,,	12 56 45		,,
2 (*n*)	II.		Bisection	,,	,,	13 0 45	12 55	,,
2	II.		Last contact	,,	,,	13 4 15		,,
3	I.	Tr. Egr.	First contact	Simms' Eq.	220	9 18 38		T.
3	I.		Bisection	,,	,,	9 20 22	9 22	,,
3	I.		Last contact	,,	,,	9 22 22		,,
4	II.	Ecl. R.	First seen	E. Eq.	210	12 28 43		L.
4	II.		Full brightness	,,	,,	12 30 28	12 28 48	,,
6	III.	Occ. D.	First contact	,,	,,	9 54 55		,,
6	III.		Last seen	,,	,,	10 3 33		,,
6	III.		First contact	Altaz.	100	9 54 7	9 57	R. W.
6	III.		Bisection	,	,,	9 57 17		,,
6	III.		Last seen	,,	,,	10 0 47		,,

Day of Obs.	Satellite.	Phenomenon.		Telescope.	Power.	Mean Solar Time of Observation. h m s	Mean Solar Time of N.A. h m s	Observer.
1886, May 6	III.	Occ. R.	First seen	E. Eq.	210	12 49 54	12 55	R. W.
6	III.		Last contact	,,	,,	12 56 55		,,
6	III.	Ecl. D.	Last seen	,,	,,	13 58 17	13 57 55	,,
18	I.	Ecl. R.	First seen	,,	,,	11 13 29	11 13 30	H.
18	I.		Full brightness	,,	,,	11 14 53		,,
20	II.	Tr. Egr.	First contact	Simms' Eq.	220	9 41 9	9 42	L.
20	II.		Last contact	,,	,,	9 47 9		,,
27	II.	Tr. Ing.	First contact	E. Eq.	210	9 23 58	9 21	T.
27 (*o*)	II.		Bisection	,,	,,	9 26 43		,,
29	II.	Ecl. R.	First seen	,,	140	9 36 29	9 36 53	A. D.
29	II.		Full brightness	,,	,,	9 41 2		,,
July 6	III.	Tr. Egr.	Bisection	,,	210	9 39 31	9 40	,,
6	III.		Last contact	,,	,,	9 42 25		,,

Notes.

(*a*) Observations considered good.
(*b*) Limb of planet somewhat tremulous, but satellite well defined.
(*c*) Satellite much brighter than *Jupiter*.
(*d*) The time recorded for bisection is probably too early.
(*e*) No trace of the satellite was visible at $12^h\ 33^m\ 30^s$, when *Jupiter* was lost in cloud; on reappearing at the time recorded the satellite was seen with some distinctness. Thick cloud then came up.
(*f*) Time recorded very uncertain, as the sky was thick and the satellites were faint.
(*g*) Planet was obscured at times by cloud.
(*h*) Definition very bad.
(*i*) Observed through a temporary break in the clouds, but considered a real observation of reappearance.
(*j*) Observation uncertain from cloud.
(*k*) Observed through cloud, but the planet was shining brilliantly when the satellite was first seen.
(*l*) Until $8^h\ 35^m$ there appeared to be a slight abruptness on *Jupiter's* limb at the point of disappearance, but the observer was inclined to consider this the effect of strain on the eye.
(*m*) Satellite well clear at $10^h\ 14^m\ 30^s$.
(*n*) Definition very bad owing to haze.
(*o*) *Jupiter* diffused.

Occultation of γ Virginis, 1886. By F. C. Penrose.

A few remarks on an observation of an occultation of *γ Virginis* on the 18th inst. may be interesting to the Royal Astronomical Society.

The morning was fine, but there were some slight clouds, and one was over the Moon near the time predicted for the reappearance, so that I could not see the grey Moon, and, as I was dependent on the position-angle at the vertex, could not use a power high enough to separate the star properly, but I think the observation was more interesting and beautiful in consequence.

At G.M.T., ± say 2^s, $16^h\ 33^m\ 32^s$, a bright flash showed the reappearance of γ_1, and exactly 10 seconds later was another flash, which seemed to double the brightness of the star.

The time was corrected by altitudes of east and west stars observed at nearly the same altitude and azimuth with a theodolite.

I got several positions of Barnard's Comet, particularly Nov. 29, Dec. 4, and Dec. 9, but they are probably liable to errors of two or three minutes of arc.

Approximate place of station, longitude $1^h\ 34^m\ 58^s$ E., and latitude $37°\ 58'\ 15''$ N.

Athens: 1886, *Dec.* 26.

Occultation of Aldebaran, Jan. 6, 1887. By the Rev. S. J. Johnson, M.A.

The occultation of *Aldebaran* on the 6th was observed here very favourably. Disappearance at $12^h\ 12^m\ 49^s$ was instantaneous; not the slightest lingering or projection on the limb, though a portion of the Moon's dark limb was left, and the sky around was perfectly clear. The star seemed to lose its redness as the Moon approached it; the emersion at $13^h\ 14^m\ 5^s$ not nearly so sudden. Star seemed to creep out leisurely from a point just north of the Mare Crisium, but some haze was present. Power 50 employed, on $3\frac{1}{4}$-inch. Time by sextant.

Melplash Vicarage, Dorset:
1887, *Jan.* 10.

Observations of Comet f 1886 (*Barnard*), *made at the Royal Observatory, Greenwich.*

(*Communicated by the Astronomer Royal.*)

The observations were made with the East or Sheepshanks Equatorial, aperture 6·7 inches, by taking transits over two cross-wires at right angles to each other, and each inclined 45° to the parallel of Declination.

Comet f 1886 (*Barnard*).

Greenwich Mean Solar Time.	Observer.	☄−★ R.A.	Corr. for Par. and Refract. in R.A.	☄−★ N.P.D.	Corr. for Par. and Refract. in N.P.D.	No. of Comp.	Apparent R.A.	Apparent N.P.D.	Comp. Star.
1886. h m s		m s	s	′ ″	″		h m s	° ′ ″	
Dec. 14 5 15 41	H. T.	+1 16·50	+0·40	− 8 38·2	−6·6	3	17 33 9·80	74 55 57·4	*a*
14 5 30 1	H. T.	−2 43·43	+0·40	+10 43·6	−5·2	3	17 33 19·57	74 56 12·8	*b*
16 5 17 25	H.	−0 11·33	+0·30	+ 3 20·4	−5·7	3	17 51 42·07	76 1 55·6	*c*
16 5 35 27	H.	−0 48·90	+0·40	+ 4 38·7	−5·7	2	17 51 49·80	76 2 16·2	*d*

Mean Places of Comparison Stars.

Star's Name.	R.A. 1886·0.	N.P.D. 1886·0.	Authority.
	h m s	° ′ ″	
(*a*) W.B. (2) XVII. 929–30	17 31 52·19	75 4 49·9	Weisse's Bessel (2)
(*b*) W.B. (2) XVII. 1110–11	17 36 1·89	74 45 42·4	Washington Catalogue 1860
(*c*) W.B. XVII. 1033	17 51 52·31	75 58 53·2	Weisse's Bessel
(*d*) W.B. XVII. 1057	17 52 37·62	75 57 52·3	,, ,,

The observations are corrected for parallax and refraction. The initials H. T. and H. are those of Mr. Turner and Mr. Hollis respectively.

Sextant Observations of Comets Fabry and Barnard.

(*Communicated by Captain H. Toynbee.*)

Comet Fabry.

Observations made on board the ship "Earl of Shaftesbury," by Captain Wm. Randall.

1886, May 5, P.M. ($9^h\ 1^m\ 30^s$ G.M.T.), Lat. 4° 12′ N. Long. 22° 0′ W.

				°	′
Nucleus of Comet to	*Sirius*	...	...	13	50
„	„ *Bellatrix*	...	...	23	54

1886, May 7 : $8^h\ 24^m\ 4^s$ Astronomical G.M.T. Lat. 3° 36′ N.; Long. 20° 0′ W.

					°	′	″
Nucleus to	*Sirius*	...	...	...	8	23	20
„	„ *Bellatrix*	...	...	...	30	34	

Comet Barnard.

Observations made on board the s.s. "Neto," by Captain Wm. G. Browne. Ship's position, Lat. 31° 54′ N.; Long. 67° 53′ W.

	h	m	s			°	′	″
Dec. 4	21	49	25	Nucleus to	*Arcturus*	24	21	20
		57	13	„	„ *Dubhe* ...	66	33	0
	22	6	4	„	„ *Spica* ...	47	32	20

Note on the Electric Illumination of the Armagh Refractor.

By J. L. E. Dreyer, Ph.D.

As inquiries have been made from several sides about the system of electric illumination adapted to the 10-inch Refractor at the Armagh Observatory by Mr. Grubb, it may be of use to give a short description of it.

The principal difficulty of connecting the eyepiece and other parts of an Equatorial with a battery is the necessity of the observer being able to turn the telescope about, and even to reverse the instrument, without getting it entangled with the connecting wires. This difficulty Mr. Grubb has obviated in a very neat manner by letting the current pass through two insulated brass rings, one of which is attached round the upper end of the polar pillar, and the other round the end of the Declination axis away from the telescope. The current passes from these rings through

brass combs sliding on them, and moving with the telescope respectively in Right Ascension and in Declination. The rings are kept clean by being from time to time rubbed with sand-paper.

The bichromate battery is placed in the porch to the east of the dome, and the wires are carried under the floor. One wire ends in a binding screw on the base casting of the Equatorial; the other passes through the base, along the outside of the polar pillar to the first of the above-mentioned rings. From the comb sliding on this the wire passes to the ring on the Declination axis; and from the comb sliding on this a wire runs along the counterpoise to the end of the Declination axis, through this and out through the "cradle" of the telescope down to the eye-end of the latter. I have here fixed a commutator, with four holes in it; by sticking a brass peg into one of these the current is sent to the lamp giving bright field illumination, or to the lamp illuminating the wires on a dark field, or to the lamp illuminating the Declination circle, or to a small hand-lamp used for throwing light on the micrometer and the note-book. From each of these lamps a wire goes to some metallic part of the telescope. The bright wire lamp is enclosed in a small brass cylinder on the micrometer, while the bright-field lamp is placed at the side of the tube opposite the Declination axis, the light being reflected down to the eyepiece by a very small central mirror on an arm which the observer, if he wishes, can put out of the way of the pencil of light from the object-glass by pushing a rod which goes down to the eye-end. The hand-lamp consists of a short brass tube with a lens at one end, and closed at the other end by a piece of wood, through which pass the wires and an ebonite rod carrying the lamp; when not in use it hangs on one of the arms to which the finder is attached.

There is no arrangement for reading the R.A. circle from the eye-end: the observer has to stand on one of two steps east and west of the pier, and reads the circle by means of a magnifying lens and an electric lamp placed in a short tube, which, when not required, hangs on a wire holder on the south end of the pier. From this lamp an "earth wire" goes to the base of the telescope mounting, and contact is made simply by resting the brass tube against an uncovered portion of the principal wire from the battery.

The incandescent lamps are from Laing, Wharton & Down, 8 and 9 Holborn Viaduct, London; the glass globes are $\frac{7}{16}$ of an inch in diameter. The bichromate battery has four cells, but only three are required for the micrometer, and one or two would be enough for illuminating the circles. The cells are very large, the glass jars being 9 inches high and 6 inches in diameter. To the metallic lids are fastened four carbons, $6\frac{1}{2}$ by $2\frac{1}{2}$ inches, and the zinc plate is 9 inches by 3 inches. By keeping the zinc plates lifted above the acid when not in use they last a long time. The whole arrangement has been found extremely convenient and clean.

Meteors with Curved Paths. By W. F. Denning.

The term "erratic" applied by Mr. Hopkins to such meteors as display curved paths appears to me inappropriate. Erratic meteors are usually understood to refer to such of these bodies as belong to unknown systems, and are therefore synonymous with sporadic meteors. The title has also been employed to denote meteors which, though probably emanating from known showers, exhibit a certain discordance in their directions, though such discordance may have been induced by perturbations exercised upon them far beyond our atmosphere, and has nothing to do with the curved paths they sometimes pursue when under ignition. The term adopted by Mr. Hopkins is not expressive of the peculiarity to which he refers it. Such words as devious, sinuous, deflected, or tortuous meteors would be preferable, as conveying a distinct idea of the anomalous flights alluded to.

As a rule, I believe the alleged crooked paths are nothing more than mere impressions. The curious flickering in the light of individual meteors often giving rise to considerable alternations in their apparent brilliancy, combined with the fact that these phenomena rarely last long enough to ensure a steady view, occasion the idea of curved flights. The observer is seldom looking towards the exact place of a meteor's course, and the glimpse he obtains is more or less hurried, imperfect, and erroneous.

On December 20, 1886, $13^h\ 11^m$, I was watching for shooting stars and looking towards the immediate region of *Gemini* and *Cancer*, when suddenly a brightish meteor shone out north of *β Leonis*. Instantly directing my eyes to the spot, I caught the end-course well, and received a very strong impression that the path was much crooked or curled, but about $1\frac{1}{2}$ sec. later a bright streak of phosphorescence came out on the course of the meteor, and I saw it was perfectly straight along its whole length. My idea as to the bent path was therefore quite illusory, and due to the scintillations of the meteor in its rapid flight which I had seen but imperfectly. I may add, that of some thousands of meteor streaks and trains observed here at various times very few have shown decided curvature.

In 1885, out of a total of 1,334 meteors recorded (omitting Andromedes of November 27), I noticed four which were conspicuously curved. In 1886 I saw 1,431 meteors, of which about fifteen exhibited the same peculiarity in a striking degree. One of the best examples of these was recorded on December 25, 1886, $8^h\ 22^m$. The meteor was 3rd mag. and moved very slowly

from between α and θ *Geminorum*; at the end it curved upwards so:—

Meteors are not infrequently broken during their flights and are observed to wax and wane several times before final disappearance. The large meteor of November 17, 1886, revived seven or eight times during its long flight of 63°, which it performed in seven seconds. Fireballs of the finest type are often accompanied with a series of outbursts and brilliant flashes directly resulting from increased combustion at certain points of their courses. Meteor streaks and trains are sometimes separated into three or four visible parts, but they are almost invariably sections of a straight line until they begin drifting under the influence of atmospheric currents, which occasionally mould them into grotesque, serpentine forms before they entirely fade from view.

As to the meteor of December 4, 1886, quoted by Mr. Hopkins, the phenomenon he describes must have been due, as Colonel Tupman suggested, to the nearly simultaneous appearance of two meteors with parallel paths, and hence, presumably, belonging to the same radiant. But the difference of 30′ is so small that it seems to me quite inappreciable when the circumstances of such observations are considered. Occasionally the beginning or end point of a meteor's flight, when near prominent stars, may be noted very accurately; but the details of the slight curve and secondary raised track of the meteor described by Mr. Hopkins would be far too trivial to be noticed by my eye or, I venture to affirm by any other eye not endowed with extraordinary powers.

Bristol: 1886, *Dec.* 31.

Erratum (in some copies).

Monthly Notices, vol. xlvii., page 56, the 8th and 9th lines from the top should be inserted between the 2nd and 3rd lines from the top of page 55.